University of Rhode Island Capstone Design Project

Automated Temperature Sample

Team members:

Jacob Findlay, Jessica Hampson, Riley Tuttle

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Acknowledgements:

We would like to express our appreciation to Professor Sunak for giving us this Capstone project. He has assisted us in making the transition from school style ethics to industrial work. Without professor Sunak taking the task of finding companies and giving projects to us, there would be no capstone design. He takes a great deal of time out of his day to assist us in any issue we are experiencing. Professor Sunak is always making sure that we are motivated in what we do. He specifically assigned us this project because he felt that we were the best fit for the job. We are constantly being asked what we have done and how our Capstone project is going. In doing so, he is keeping us focused on the work we need to get done and being sure that, in the process of all this work, we are doing what we enjoy. We all decided to be an Engineer for a reason and he wants to be sure that we are assigned a project that we feel passionate about. It is greatly appreciated that Professor Sunak is always there for any student who is in need of a question, not only about school work but also how to exceed in industry. If there is a question, he will always have an answer. We thank him for his motivational support and his willingness to always be there.

We would also like to extend our gratitude to Dave Grande for guiding us along on this project. We all went in blindly, hoping to get the right project for us and Dave was hoping to get the right people for the job. He has helped us jump start the project and send us in the right direction. By giving us multiple resources and advice to help us tackle the problems from this project, he is pushing us along in the process. By meeting with him weekly, it helps us to stay in contact and be sure of exactly what we are doing. We appreciate that he spends this time every week because it helps us get to know each other better and learn what we all want to get out of the project. Dave is there for any question we have and is sure to help us with any other problems we seem to be having. He has divided the work equally and has experience in making sure we get it all done. We thank him for his endless support and assistance throughout this project.

Project Description:

Project Summary:

Our design project is the automated temperature sampler for Eagle Electric Engineering Enterprise. The design project consists of developing a device that will travel around the ribs of a submarine as the hull is being welded on. As this sampler is travelling around the rings that make up the ribs it will periodically stop and sample the temperature of hull. It will then send the temperature and location data to an HMI device that a welding technicians can look at in order to determine which part of the hull is ready to be welded into place. The technician is not required to watch the machine the entire time. The sole purpose of the machine is to gather temperatures for the welders.

To accomplish this task the sampler will essentially be constructed as an upside down 'U' shape with three rollers: one on each side facing inward. The whole assembly will sit on the upper edge of the rib. One of the rollers will be driven and another will be encoded so that the sampler can keep track of itself. Whenever it stops to sample, a probe will extend out until it touches the hull. When the device finishes sampling, it will retract the probe and send the temperature and location data to the HMI device. It will then continue along the rib until it reaches its next sample point. It will avoid the welding technicians using ultrasonic sensor and if someone or something is detected, the sampler will either wait for the obstruction to move or it will go back around the ribs in the other direction. The HMI device will be an android tablet with an accompanying app. This app will have rudimentary controls to start and stop the device and a simple display showing the temperature of the hull along different points of the rib.

The body of the sampler will be constructed from aluminum to keep it both durable and lightweight. This will increase the speed of the sampler, its efficiency, and its longevity. The microcontrollers of the sampler and all the circuitry, barring motors, temperature probe, and ultrasonic sensors, will be enclosed to protect from the harsh welding environment and mitigate some potential points of failure.

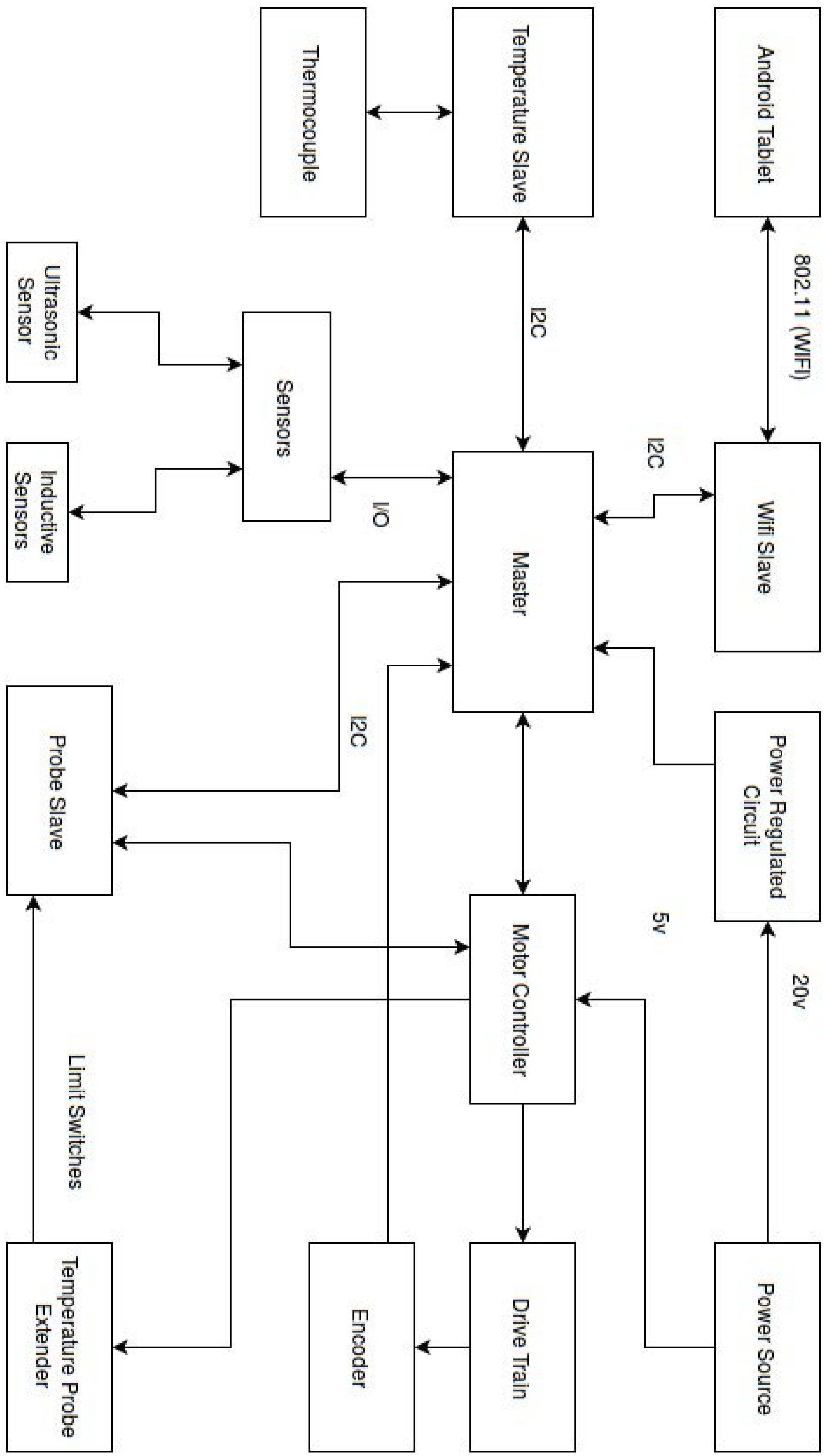
Motivation For Project:

The process of building a submarine is extremely rigorous. Since every component is mission critical there is no other choice but to make the absolute best welds possible. If the hull is not the right temperature before welding expand and deform. When the welded hull is cooled it will be warped, putting extra stresses on the welds increasing the weld's chances to fail. Normally the hulls are heated with large heaters to prevent this. Unfortunately these heaters are powerful enough to overheat the metal which causes the same types of problems as underheated metal. Previously 4E had developed a system of temperature probes attached directly to the heaters. Due to the technicians many duties they often would not retract the probes between uses which resulted in destroyed probes and bad temperature readings. Currently the system in place is to mark the hull with a wax marker. As soon as the wax melts the technicians know that the hull is at least hot enough to weld, potentially hotter. With this in mind 4E was contracted to construct a sampler that would do the job of the heater temperature probes more accurately and without the technicians having to retract the probes between uses.

Functional Specifications:

- Run Time
  - Last for eight hours (work Day)
- Speed
  - Able to complete one lap of 150 feet in circumference in a minute
- Durability
  - Withstand hard labor use
  - Withstand heat
  - Needs to be able to work through dust and grease
- Cost
  - Reasonable low cost for productivity
- Accuracy
  - Measure very accurate temperature to ensure readings are true
- Controls
  - Motors need to run on 20 volts DC
  - 4 arduinos are being used to control the sampler. 3 slaves and 1 master.
  - Encoder needs to measure current distance to within an inch over the circumference of the ring

Block Diagrams:



Details of Product Specifications:

Motor Controls:

- DF-MD 2A Dual Motor Controller
- Dynapar Series E12 Encoder

Microprocessors/sensors:

- Arduino Mega ADK
    - Arduino wifi shield
        - micro sd card 2 gb
- Atmega 168 chips (slaves)
- MAX31855 PMB1 Thermocouple-to-Digital converter
- HRLV-MaxSonar-EZ-Series
- Pepperl + Fuchs Inductive Sensor NBB5-18GM50-E0

Battery:

- DeWalt 20V Max Premium XR 5.0 Ah Lithium Ion Battery

PCB:

- Designed from ExpressPCB software
- Purchased from their website

MD1.3 2A Dual Motor Controller SKU DRI0002

Contents [hide]

MD1.3 2A Dual Motor Controller (SKU: DRI0002)

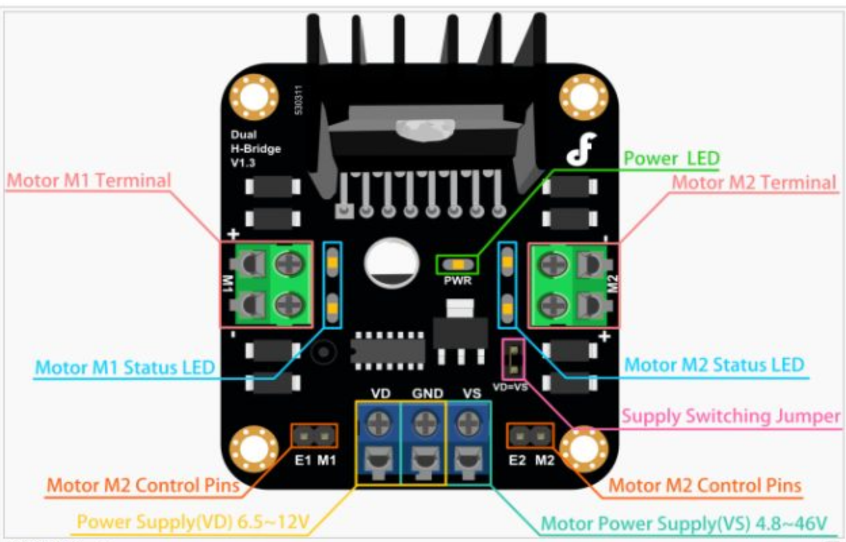
Introduction

This is a 4.8-46V, 2A Dual Motor Controller which is the revised version of the DF-MDV1.0. Its performance has been improved greatly. It can bear larger current due to the increased haetsink dissipation. It is easy to control, using LGS's outstanding high-power motor driver chip, the L298N. This chip allows for direct drive of two bi-directional DC motors, and incorporates high-speed short diodes for protection. Drive current up to 2A per motor output. The driver uses a broad-brush design to reduce wire resistance.

Specifications

- The logic part of the input voltage: 6 ~ 12V
- Driven part of the input voltage Vs: 4.8 ~ 46V
- The logical part of the work current Iss: 36mA
- Drive part of the operating current Io: 2A
- Maximum power dissipation: 25W (T = 75 degree Celsius)
- Control signal input level:
- High level: 2.3V = Vin = Vss
- Low:-0.3V = Vin = 1.5V
- Operating temperature: -25 degree Celsius ~ +130 degree Celsius
- Drive Type: Dual high-power H-bridge driver
- Module Size: 47 mm × 53mm
- Module Weight: About 29g

Pin Out



DRI0002 Pinout

SERIES E12

Dynapar™ brand

Miniature Encoder

Key Features

- Rugged Metal Housing
- Sub-Compact 1.2" Diameter
- Up to 1024PPR with Optional Index

RoHS

SPECIFICATIONS

STANDARD OPERATING CHARACTERISTICS

Code: Incremental

Resolution: 100 to 1024 PPR (pulses/ revolution)

Format: Two channel quadrature (AB)with optional Index (Z) outputs

Phase Sense: A leads B for CW shaft rotation as viewed from the shaft end of the encoder

Accuracy: ±3 x (360 ° ÷PPR)or ± 2.5 arc-min worst case pulse to any other pulse, whichever is less

Quadrature Phasing: 90 ° ± 36 ° electrical

Symmetry: 180 ° ± 18 ° electrical

Index: 90 ° ± 25 ° (gated with A and B high)

Waveforms: Squarewave with rise and fall times less than 1 microsecond into a load capacitance of 1000 pf

ELECTRICAL

Input Power: 5 VDC ± 5% at 80 mA max.; 12 or 15 VDC ± 10% at 80 mA max.; not including output loads

Outputs: 7272 line driver (or equivalent), 40 mA sink and source

Frequency Response: 100 kHz min.

Electrical Connections

Function (If Used)	Wire Color Code
Supply	Red
Common	Black
Signal A	White
Signal B	Green
Signal Z	Orange
Floating	Shield

ENVIRONMENTAL

Operating Temperature: 0 to +70 °C

Storage Temperature: –25 to +70 °C

Humidity: to 98% without condensation

Enclosure Rating: NEMA12/IP54 (dirt tight, splashproof)

LSI/CSI

LSI Computer Systems, Inc. 1235 Walt Whitman Road, Melville, NY 11747 (631) 271-0400 FAX (631) 271-0405

LS7166

August 2007

24-BIT QUADRATURE COUNTER

FEATURES:

- Programmable modes are: Up/Down, Binary, BCD, 24 Hour Clock, Divide-by-N, x1 or x2 or x4 Quadrature and Single-Cycle.
- DC to 25MHz Count Frequency.
- 8-Bit I/O Bus for uP Communication and Control.
- 24-Bit comparator for pre-set count comparison.
- Readable status register.
- Input/Output TTL and CMOS compatible.
- 3V to 5.5V operation (V_{DD} - V_{SS}).
- LS7166 (DIP); LS7166-S (SOIC); LS7166-TS24 (24-Pin TSSOP) **- See Figure 1 -**

GENERAL DESCRIPTION:

The LS7166 is a CMOS, 24-bit counter that can be programmed to operate in several different modes. The operating mode is set up by writing control words into internal control registers (see Figure 8). There are three 6-bit and one 2-bit control registers for setting up the circuit functional characteristics. In addition to the control registers, there is a 5-bit output status register (OSR) that indicates the current counter status. The IC communicates with external circuits through an 8-bit three state I/O bus. Control and data words are written into the LS7166 through the bus. In addition to the I/O bus, there are a number of discrete inputs and outputs to facilitate instantaneous hardware based control functions and instantaneous status indication.

REGISTER DESCRIPTION:

Internal hardware registers are accessible through the I/O bus (D0 - D7) for READ or WRITE when $\overline{CS}$ = 0. The C/$\overline{D}$ input selects between the control registers (C/$\overline{D}$ = 1) and the data registers (C/$\overline{D}$ = 0) during a READ or WRITE operation. (See Table 1)

PIN ASSIGNMENTS - Top View

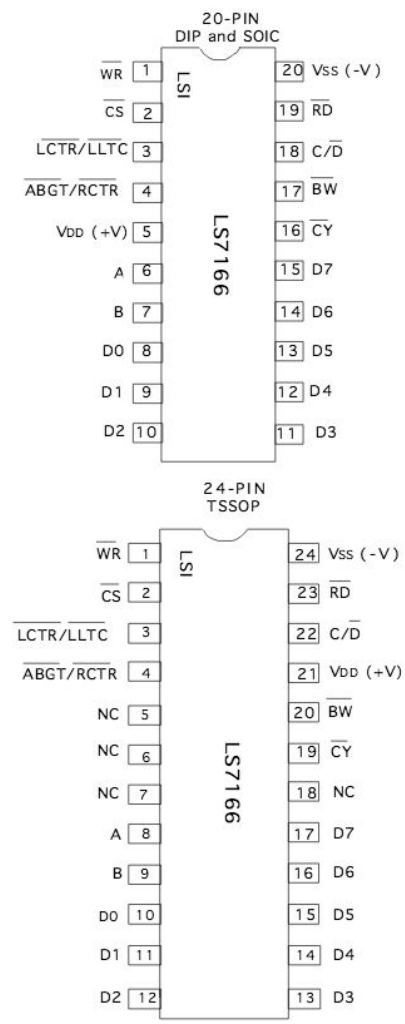
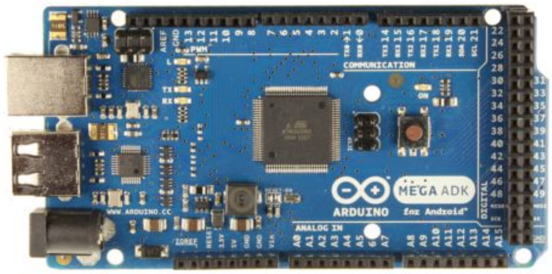
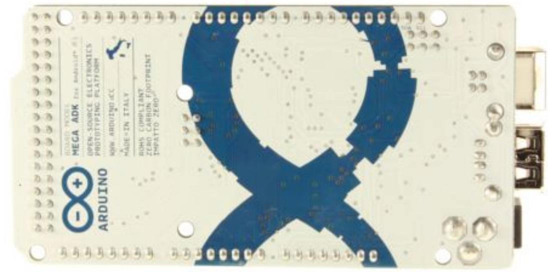


FIGURE 1

Arduino MEGA ADK



Arduino MEGA ADK R3 Front



Arduino MEGA ADK R3 Back

Arduino MEGA ADK Front

Arduino MEGA ADK Back

Overview

The Arduino MEGA ADK is a microcontroller board based on the ATmega2560 (datasheet). It has a USB host interface to connect with Android based phones, based on the MAX3421e IC. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

The MEGA ADK is based on the Mega 2560.

Similar to the Mega 2560 and Uno, it features an ATmega8U2 programmed as a USB-to-serial converter.
Revision 2 of the Mega ADK board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.
Revision 3 of the board has the following new features:

- 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes.
- Stronger RESET circuit.

For information on using the board with the Android OS, see:

- Google's ADK documentation.

MAX31855

Cold-Junction Compensated Thermocouple-to-Digital Converter

Accurate Thermocouple-to-Digital Converter IC Simplifies Designs and Lowers System Cost

Data Sheet   Subscribe   Active: In Production.

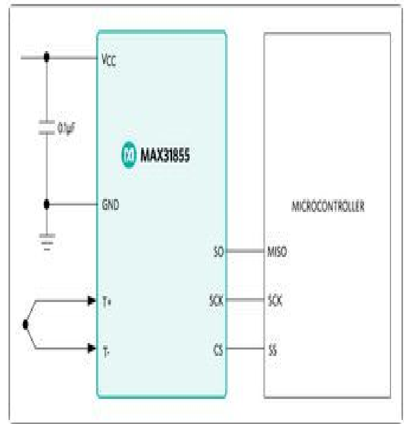
OVERVIEW | KEY SPECS | DESIGN RESOURCES | ORDER

Description

The MAX31855 performs cold-junction compensation and digitizes the signal from a K-, J-, N-, T-, S-, R-, or E-type thermocouple. The data is output in a signed 14-bit, SPI-compatible, read-only format. This converter resolves temperatures to 0.25°C, allows readings as high as +1800°C and as low as -270°C, and exhibits thermocouple accuracy of ±2°C for temperatures ranging from -200°C to +700°C for K-type thermocouples. For full range accuracies and other thermocouple types, see the *Thermal Characteristics* specifications in the full data sheet.

FAQs: MAX31855

MAX31855: Typical Application Circuit



Enlarge+

Key Features

- Integration Reduces Design Time and Lowers System Cost
    - 14-Bit, 0.25°C Resolution Converter
    - Integrated Cold-Junction Compensation
    - Versions Available for Most Common Thermocouple Types: K-, J-, N-, T-, S-, R-, and E-Type
    - Detects Thermocouple Shorts to GND or V_{CC}
    - Detects Open Thermocouple
- Interfaces to Most Microcontrollers
    - Simple SPI-Compatible Interface (Read-Only)

Applications/Uses

- Appliances
- Automotive
- HVAC
- Industrial

HRLV-MaxSonar®- EZ™ Series

High Resolution, Precision, Low Voltage Ultrasonic Range Finder
MB1003, MB1013, MB1023, MB1033, MB1043

The HRLV-MaxSonar-EZ sensor line is the most cost-effective solution for applications where precision range-finding, low-voltage operation, and low-cost are needed. This sensor component module allows users of other more costly precision rangefinders to lower the cost of their systems without sacrificing performance.
The HRLV-MaxSonar-EZ sensor line provides high accuracy and high resolution ultrasonic proximity detection and ranging in air, in a package less than one cubic inch. This sensor line features 1-mm resolution, target-size and operating-voltage compensation for improved accuracy, superior rejection of outside noise sources, internal speed-of-sound temperature compensation and optional external speed-of-sound temperature compensation. This ultrasonic sensor detects objects from 1-mm to 5-meters, senses range to objects from 30-cm to 5-meters, with large objects closer than 30-cm are typically reported as 30-cm[1]. The interface output formats are pulse width, analog voltage, and serial digital in either RS232 or TTL. Factory calibration is standard. [1]**See Close Range Operation**

Precision Range Sensing
- Range-finding at a fraction of the cost of other precision rangefinders
- Reading-to-reading stability of 1-mm at 1-meter is typical
- Accuracy is factory-matched at 1-meter to 0.1% providing a typical large target accuracy of 1% or better for most voltages and uses[2]
- Calibrated acoustic detection zones allows selection of the part number that matches a specific application
- Compensation for target size variation and operating voltage range
- Standard internal temperature compensation and optional external temperature compensation

Range Outputs
- Pulse width, (1uS/mm)
- Analog Voltage, (5mm resolution)
- Serial, (RS232 or TTL using solder-able jumper or volume orders available as no-cost factory installed

Easy to Use Component Module
- Gracefully handles other ultrasonic sensors[4]
- Stable and reliable range readings and excellent noise rejection make the sensor easy to use
- Easy to use interface with distance provided in a variety of outputs
- Target size compensation provides greater consistency and accuracy when switching targets
- Sensor automatically handles acoustic noise[2,3]
- Sensor ignores other acoustic noise sources
- Small and easy to mount
- Calibrated sensor eliminates most sensor to sensor variations
- Very low power ranger, excellent for multiple sensors or battery based systems

General Characteristics

- Object proximity detection from 1-mm to 5-meters
- Resolution of 1-mm
- Excellent[5] Mean Time Between Failure (MTBF)
- Triggered operation yields a real-time
- 100mS measurement cycle
- Free run operation uses a 2Hz filter, with 100mS measurement and output cycle
- Operating temperature range from -15°C to +65°C, provided proper frost prevention is employed
- Operating voltage from 2.5V to 5.5V
- Nominal current draw of 2.5mA at 3.3V, and 3.1mA at 5V
- Low current draw reduces current drain for battery operation
- Fast first reading after power-up eases battery requirements

Notes:
[2]Users are encouraged to evaluate the sensor

PRODUCT OVERVIEW Model # DCB204-2 | Internet # 204311278

The 20-Volt MAX XR lithium-ion battery outperforms every DEWALT battery that came before it and that's saying a lot. Get long-lasting power and prolonged life from this 4Ah battery that weighs just 1.42 lbs. Each battery has a built-in charge meter so you know how much power remains. DEWALT delivers huge value with this multi-pack, priced only marginally higher than a single device.

- Includes: (2) 20-Volt MAX XR high-capacity lithium-ion batteries
- Compatible with all DEWALT 20-Volt MAX lithium-ion chargers and power tools (sold separately)
- Batteries maintain charge when not in use
- 3-year free service agreement
- Compatible with the entire line of DEWALT 20-Volt MAX tools
- 4.0 Amp hour packs

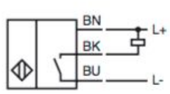
Model Number

NBB5-18GM50-E0

Features

- **Basic series**
- **5 mm embeddable**

Connection

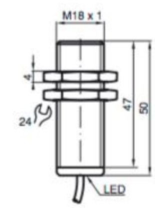


Accessories

BF 18
Mounting flange, 18 mm

EXG-18
Quick mounting bracket with dead stop

Dimensions



Technical Data

General specifications		
Switching element function		NPN NO
Rated operating distance	s_n	5 mm
Installation		embeddable
Output polarity		DC
Assured operating distance	s_a	0 ... 4.05 mm
Reduction factor r_{Al}		0.3
Reduction factor r_{Cu}		0.3
Reduction factor r_{303}		0.7
Nominal ratings		
Operating voltage	U_B	10 ... 30 V
Switching frequency	f	0 ... 800 Hz
Reverse polarity protected		reverse polarity protected
Short-circuit protection		pulsing
Voltage drop	U_d	≤ 3 V
Operating current	I_L	0 ... 200 mA
Off-state current	I_r	0 ... 0.5 mA typ. 0.1 µA at 25 °C
No-load supply current	I_0	≤ 20 mA
Indication of the switching state		all direction LED, yellow
Functional safety related parameters		
$MTTF_d$		2010 a
Mission Time (T_M)		20 a
Diagnostic Coverage (DC)		0 %
Ambient conditions		
Ambient temperature		-25 ... 70 °C (-13 ... 158 °F)
Mechanical specifications		
Connection type		cable PVC , 2 m
Core cross-section		0.34 mm^2
Housing material		brass, nickel-plated
Sensing face		PBT
Protection degree		IP67
Compliance with standards and directives		
Standard conformity		
Standards		EN 60947-5-2:2007 IEC 60947-5-2:2007
Approvals and certificates		
UL approval		cULus Listed, General Purpose
CSA approval		cCSAus Listed, General Purpose
CCC approval		Products with a maximum operating voltage of ≤36 V do not bear a CCC marking because they do not require approval.

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ABET OUTCOME C:

While designing and constructing the Sampler we learned how design within economic and safety constraints even though the only constraints that we really had were engineering constraints. Our technical director took care of the economic constraints by buying all the parts we needed and presumably the only safety constraint that we had was to make sure that the thing didn't blow up.

To reduce the cwost of the overall product, our director had a lot of extra parts laying around his office. Specifically, we used the capacitors, a few chips, and the scrap metal that he already had. This was convenient when testing different parts because quite a bit of the components were on hand and we didn't have to wait to get them. It also was great because our technical director did not have to buy some of the small things we used when testing and building the circuit.

Other than basic engineering constraints, we did not have to deal with any budget or safety constraints. Our Director told us to develop a parts list and he would purchase the parts. Frequently he even found parts for us that were more expensive versions of the parts that we needed. The main components that took up most of the cost included the frame or structure of the Sampler which was made out of Aluminum. Aluminum is an expensive material and also is expensive to cut and design specific parts for. The encoder, Dynapar Series 12, was one of the more pricey components purchases for this project. At first we had used a different version encoder which was cheaper but was eventually found out that the more expensive encoder functioned better and would have a more accurate and precise reading of the Sampler's position. Another set of components that were included in the budget were the purchasing of the PCB's because they were all custom and designed on a small scale, they had an increased cost.

As far as safety constraints we were not particularly concerned with anything. The sampler is not inherently dangerous. Even if something in the power circuit shorted out and became dangerous, the sampler would cease to function, so it could be argued that functionality is a more pressing concern. There are sensors on the Sampler that prohibit it from colliding with people or the welders. This could be viewed as a safety concern, but again the Sampler would not function properly if it was constantly colliding with objects. So functionality took priority and catering to that happened to also take care of any safety concerns that may have popped up.

Summary of Technical Accomplished by the TEAM as a whole:

- Assembled a prototype on an old RC car
- Tested out each individual component to ensure they all worked
- PCB
  - Began the PCB design using expressPCB software
  - Researched pin inputs and outputs for every piece needed in the PCB
    - Gained knowledge of what each pin is used for and where it should plugged into
  - Draw detailed schematic with specific pin inputs and outputs
    - Complete finalized typed printout for all the circuits and their pin layouts
  - Combine the group pin inputs and outputs so there are no conflicting wires involved
  - Found exact measurements for each component on pcb and placed into pcb for accurate readings
  - Added resistors and capacitors into the design along with heat shields for voltage regulators
- Data Collection and Transmission
  - Wrote a communication protocol to allow the masters and slaves to transmit data between each other
  - Wrote code to read in data from the slaves send it to the master. The master then sent the data to the web server slave which served the text file to the network
  - Designed an app to display the collected data collected in a list format.
- Project was a success
  - As a team each member had reached his/her goals set from the beginning
  - Project was completed as a prototype but is still not complete for industry use

My Individual Technical Contributions to-date by Jacob Findlay:

- Assembled prototype on an old RC car that I had
- Tested each component we had on the rc car to understand functionality
  - Tested out the rc car with all components at once to see design at full operation
- Helped Riley with some of the communication code between Arduinos
- Designed PCB's using expressPCB software
  - Finished PCB design
- Showed project director so he can give the approval to purchase
  - Used the PCB in replacement of circuit boards on the sampler

- Worked furthermore with Riley on the code to advance its capabilities and functions
- Helped director with the structure of the design while it is being created
- Analyzed test runs of the sampler once it was fully built
  - Made changes to sampler after test runs are completed
  - Finished last minute design changes to ensure sampler is fully operational with minimum glitches

My Individual Technical Contributions to-date by Jessica Hampson:

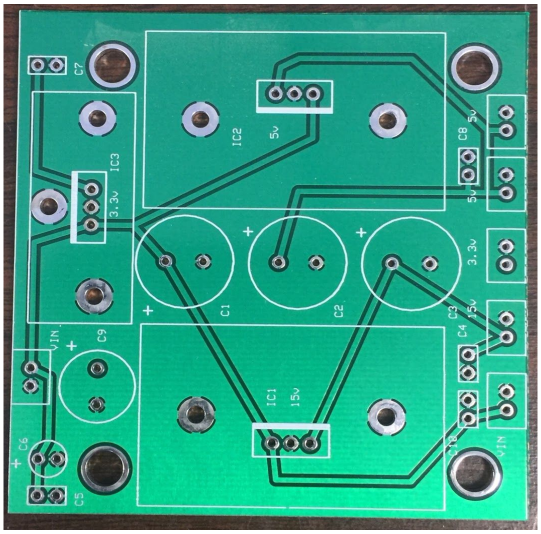
- Pre-PCB
  - Purchase parts for circuit
  - Build circuit to make sure it functions properly
    - Test each piece (component) individually
    - Slowly combine parts to test them together on breadboard
  - Used RC car to represent functionality of circuit board (prototype)
    - Tested components on the RC car to be sure they will work as expected
    - Used RC to test entire circuit, when put together to be sure it functions properly as a whole
- PCB design
  - Draw detailed schematic of each board needed for the design
  - Draw designs on the computer
  - Get director's approval in the design of the board
  - Print boards
  - Analyze testing on the sampler once it is fully built
  - Make sure everything runs smoothly and adjust any issues that come up during the testing process

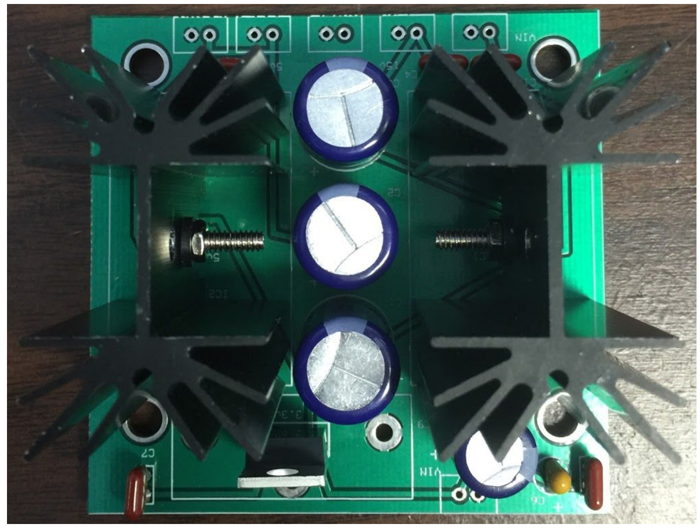
My Individual Technical Contributions by Riley Tuttle:

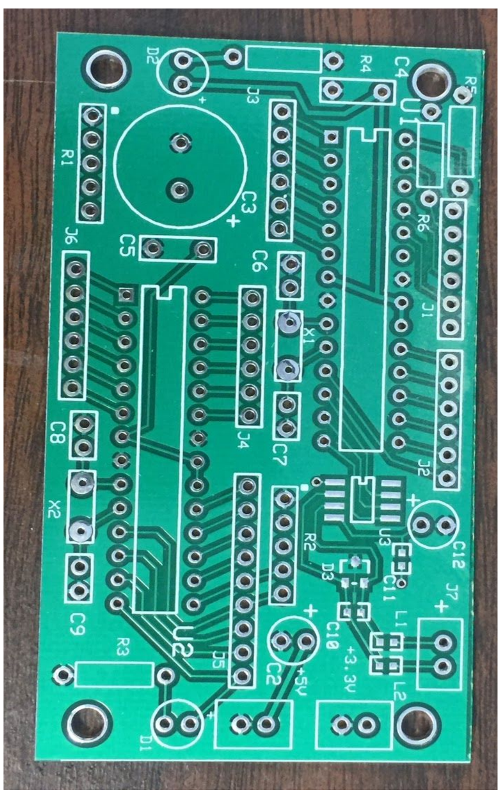
- Sampler behavior protocol
    - Implemented only enough control to work as the demo. Focus was on the data collection, transmission, and app
- Communication protocol
    - Made a framework communication protocol that can be applied to the master and slave arduinos
        - This allows the master to send commands and data to the slaves and the slaves to send data back to the master
- Webserving
    - Wrote code for an arduino Yun that is being used as the webserver slave. The master sends it all the data. It then saves the data to an sd card in a text file and is a webserver that serves that text file to the network.
- App
    - Wrote an app that connects to the webserver, reads in the text file and parses the text into an array of time, location, temperature groups. It then displays the values in a list format.

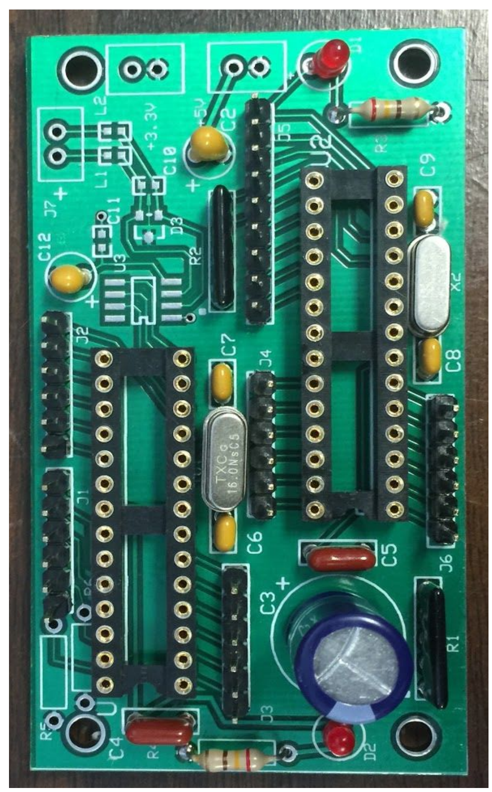
Details of Results and Discussions:

Below are some pictures of results that include the multiple PCB's that were designed and purchased. This includes the software pictures of the design and also the final product of the PCB.

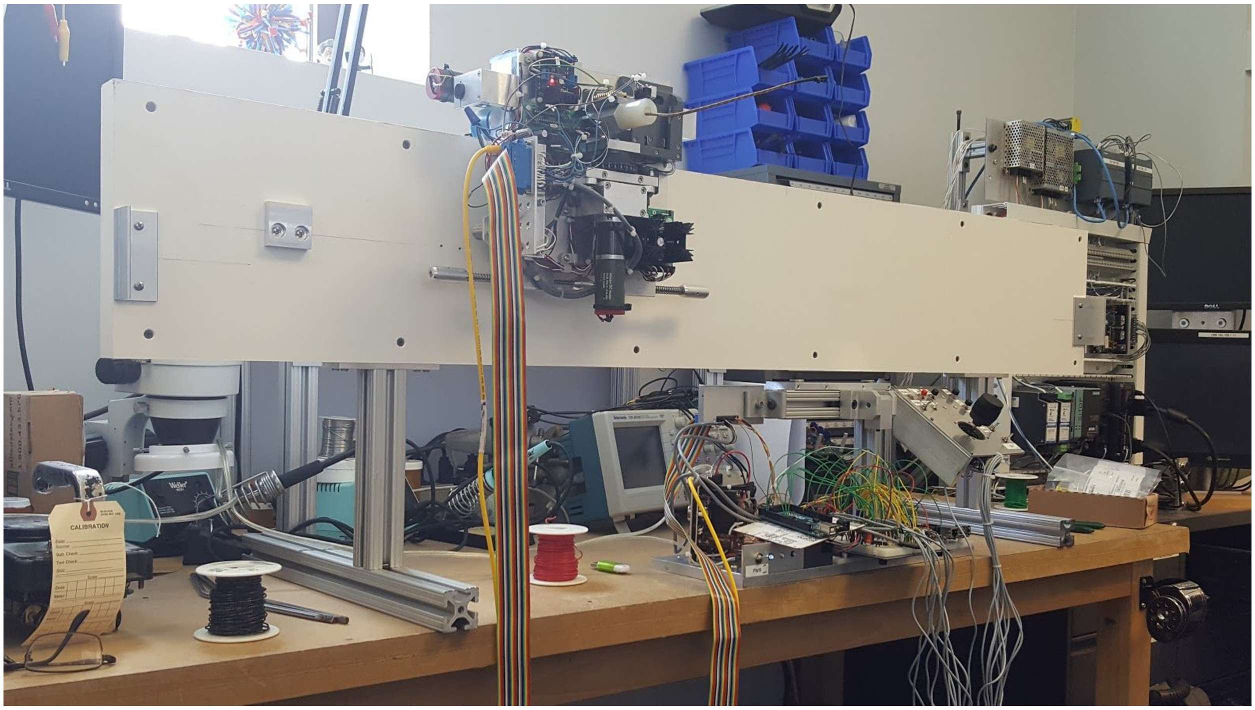








Below is a picture of the sampler being tested on a mockup submarine ring.



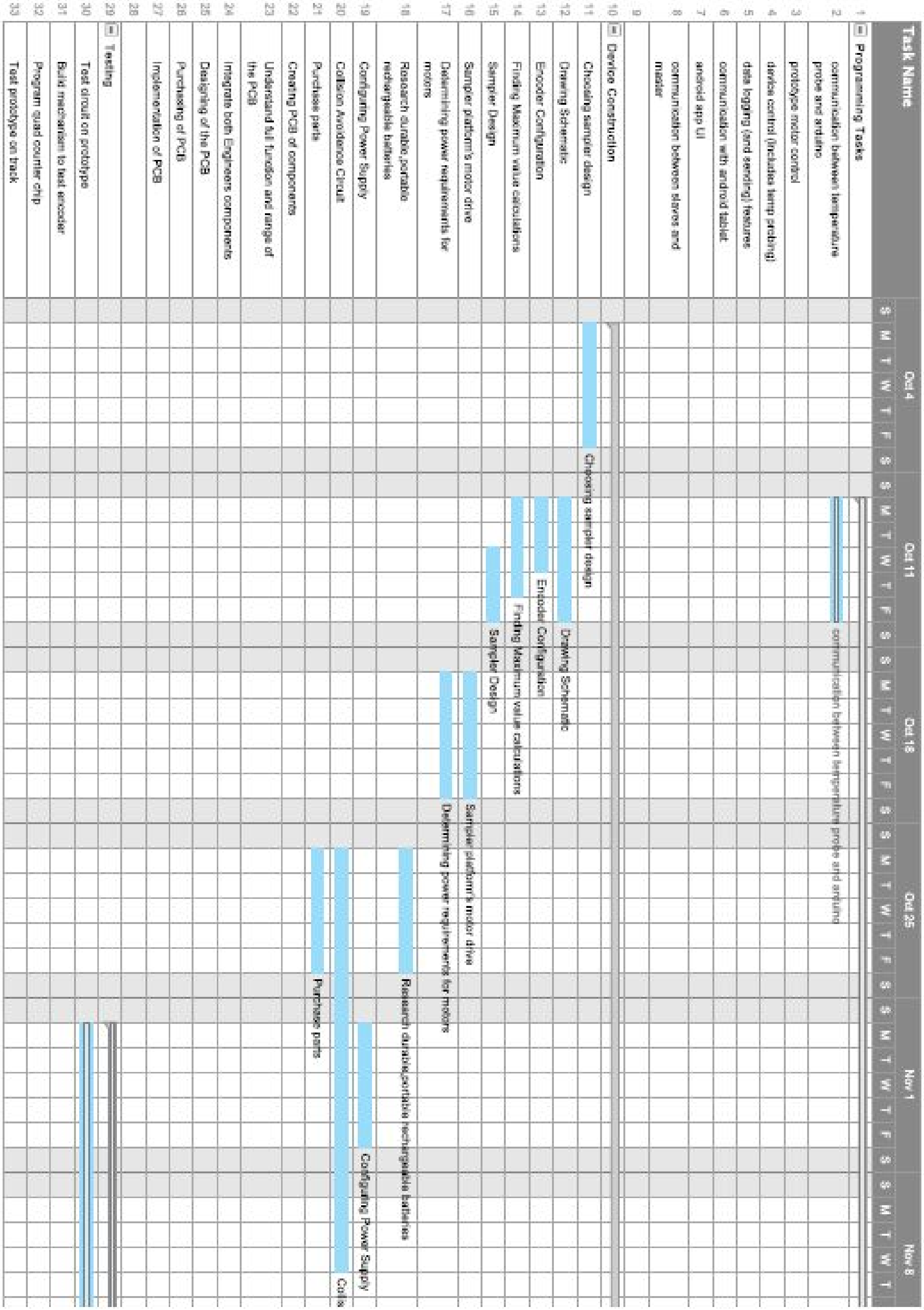
Project Continuation:

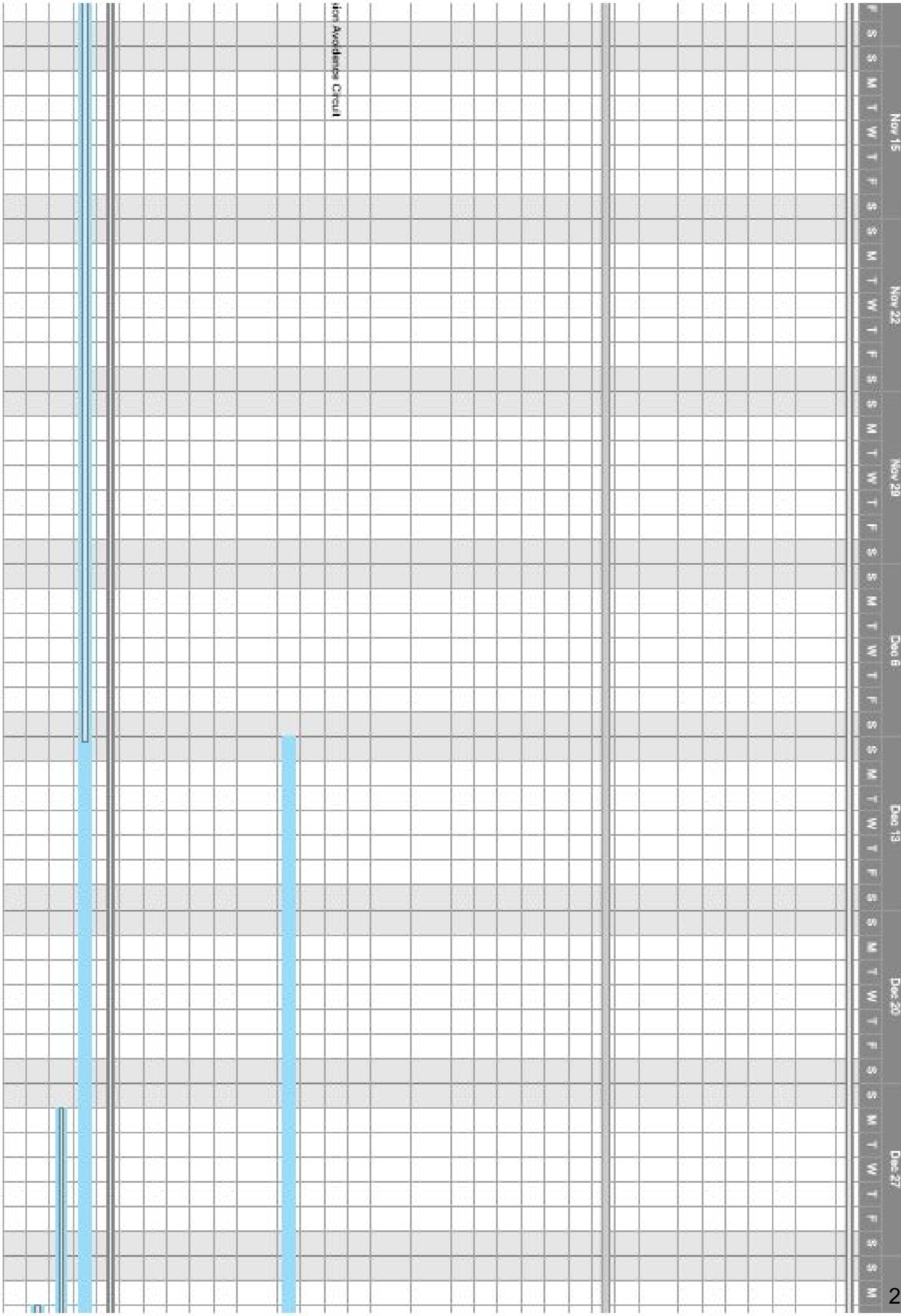
Assuming that another group was going to take over next year, there wouldn't be much to complete based on what our goals were to be completed this semester. If our director were to add on other constraints or added components, then there could be work for the next year's capstone group. The next team would have essentially the sampler with all the input and output already designed and working. The sampler does not have an array of locations to hit yet, so that could be done. The sampler only has one way communication with the tablet. Later on, if someone wanted to change this, it may mean redesigning the method of communication entirely because we just so happened to choose the first type of communication that worked. The tablet could also be a little more visually intuitive, with a model of a ring. Right now, the tablet is just listing the data. Some of the behavior of the sampler is not thoroughly designed, so decisions have to be made about how the sampler should behave in certain situations. Other improvements could be focusing on the durability of the Sampler, right now the Sampler even though it works, it is very fragile in terms of wires being disconnected and the code need to have more redundancies. Overall, the sampler is physically robust, but it is not very robust in terms of protocols.

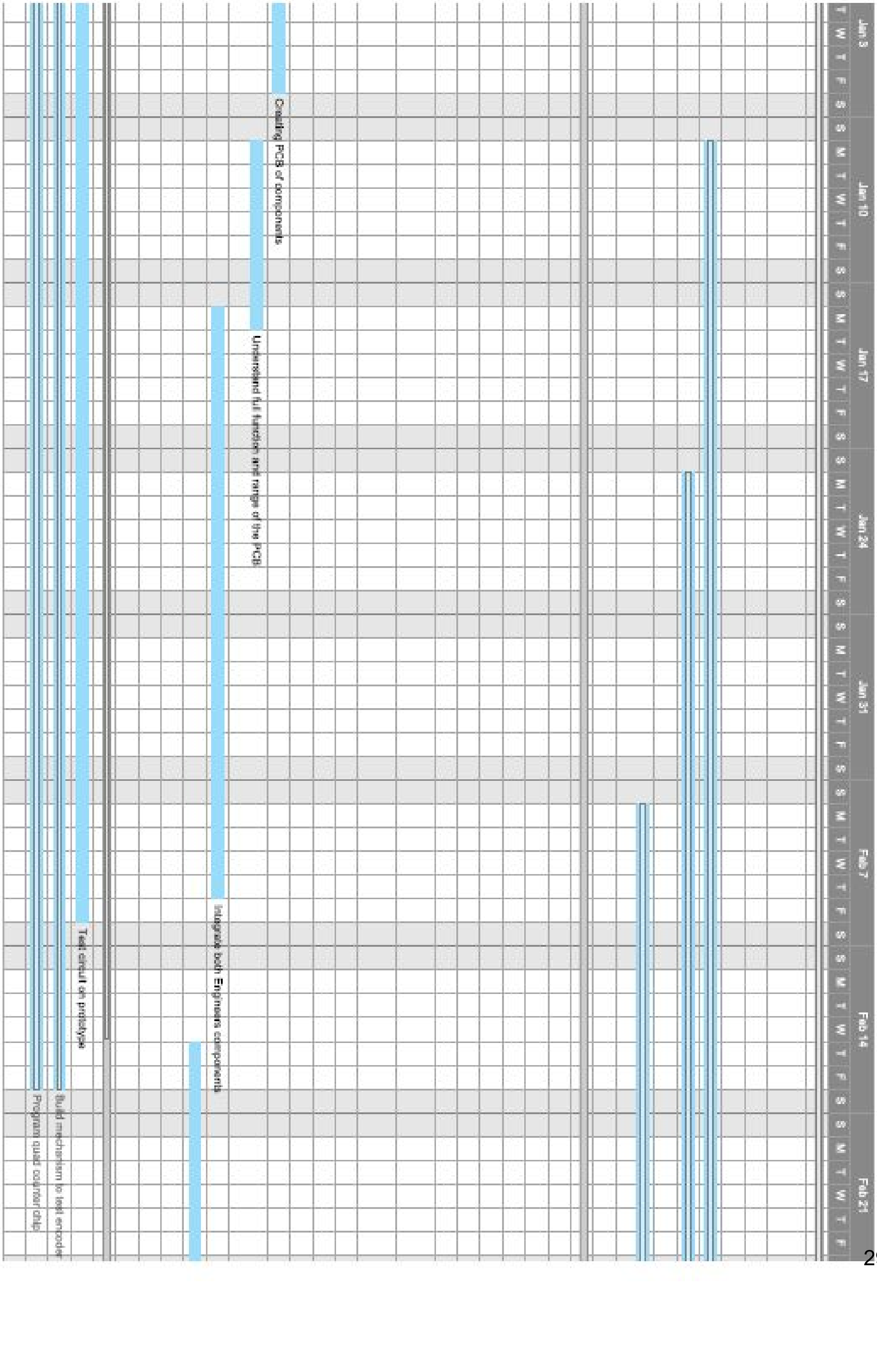
References:

- Motor Controller
  - http://www.dfrobot.com/wiki/index.php/MD1.3_2A_Dual_Motor_Controller_SKU_DRI0002
- Thermocouple to Digital Converter
  - http://datasheets.maximintegrated.com/en/ds/MAX31855.pdf
- Encoder
  - http://www.usdigital.com/products/encoders/incremental/rotary/shaft/H1
- Counter chip
  - http://hades.mech.northwestern.edu/index.php/Using_the_LS7166_Quadrature_Counter
- Microcontroller
  - https://www.arduino.cc/en/Main/ArduinoBoardMegaADK
- Ultrasonic Sensor
  - http://www.maxbotix.com/documents/HRLV-MaxSonar-EZ_Datasheet.pdf
- Step-down Voltage Regulator
  - http://datasheets.maximintegrated.com/en/ds/MAX5023-MAX5024.pdf
- Battery connector
  - http://www.ereplacementparts.com/dewalt-dcf885c2-type-20v-impact-driver-parts-c-1009_9591_157719.html
- Inductive Sensor
  - http://www.farnell.com/datasheets/1449357.pdf

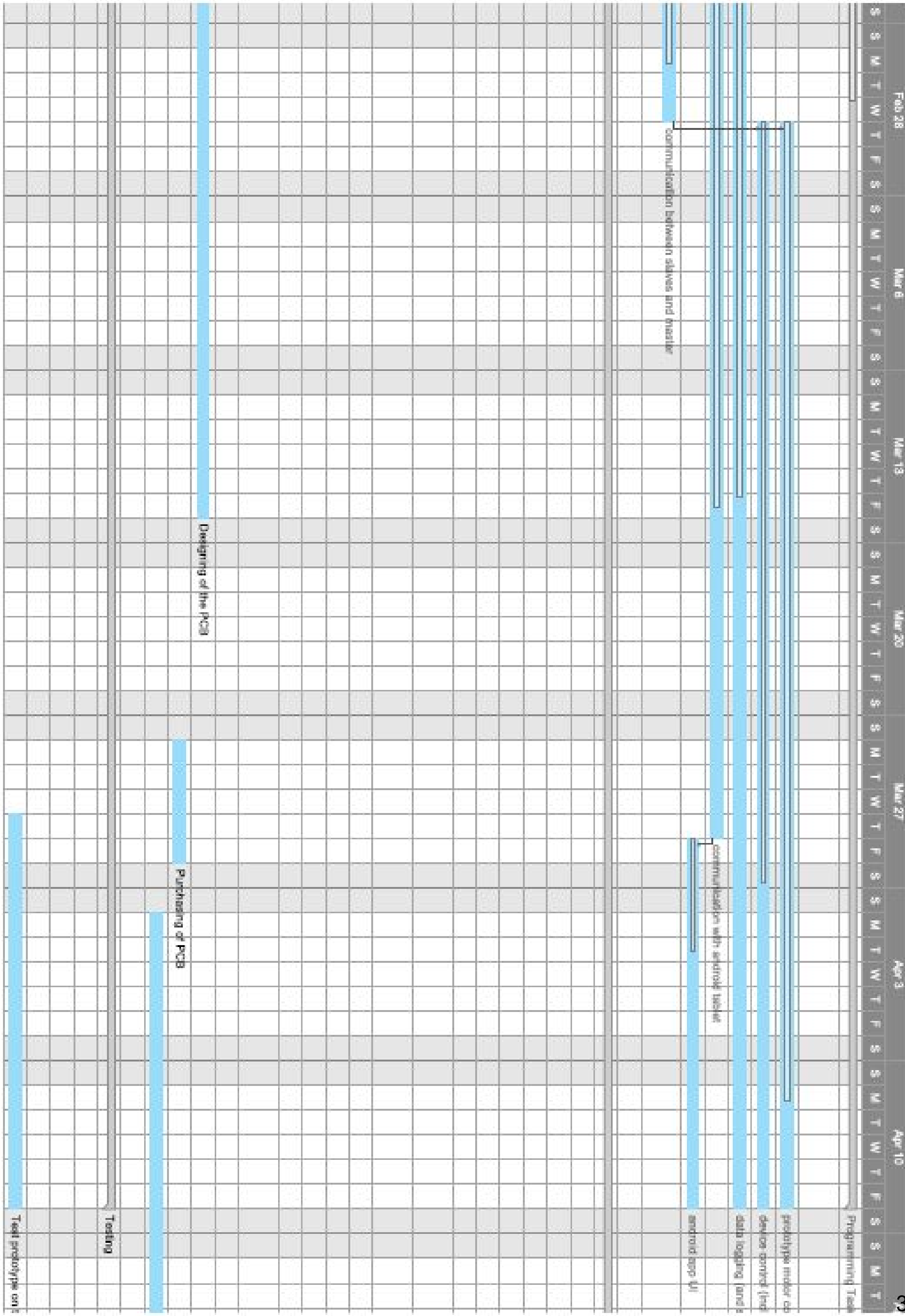
Gantt Chart:

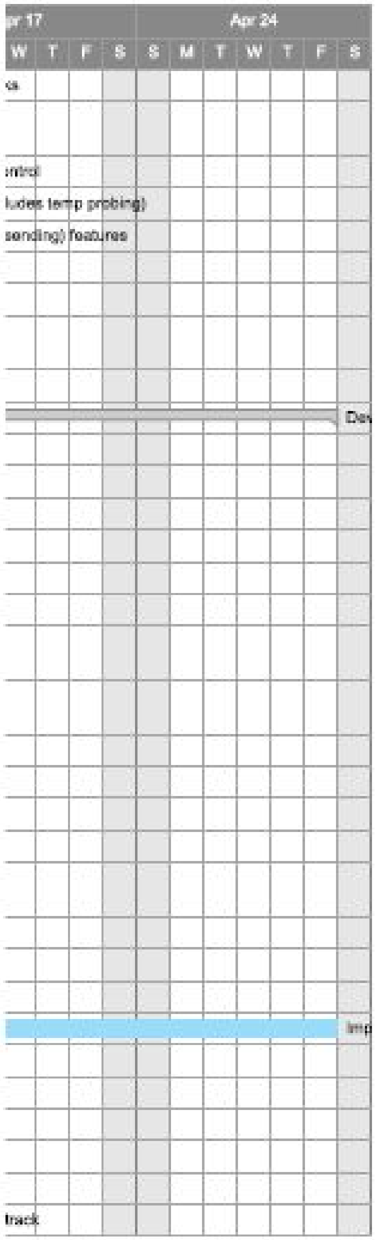

Task Name
Oct 4
Oct 11
Oct 18
Oct 25
Nov 1
Nov 8
Programming Tasks
communication between temperature probe and arduino
prototype motor control
device control (includes temp probing)
data logging (and sending) features
communication with android tablet
android app UI
communication between slaves and master
Device Construction
Choosing sampler design
Drawing Schematic
Encoder Configuration
Finding Maximum value calculations
Sampler Design
Sampler platform's motor drive
Determining power requirements for motors
Research durable,portable rechargeable batteries
Configuring Power Supply
Collision Avoidance Circuit
Purchase parts
Creating PCB of components
Understand full function and range of the PCB
Integrate both Engineers components
Designing of the PCB
Purchasing of PCB
Implementation of PCB
Testing
Test circuit on prototype
Build mechanism to test encoder
Program quad counter chip
Test prototype on track


ion Avoidance Circuit
Nov 15
Nov 22
Nov 29
Dec 6
Dec 13
Dec 20
Dec 27



Jan 3
Jan 10
Jan 17
Jan 24
Jan 31
Feb 7
Feb 14
Feb 21
Creating PCB of components
Understand full function and range of the PCB
Integrate both Engineers components
Test circuit on prototype
Build mechanism to test encoder
Program quad counter chip


Feb 28
Mar 6
Mar 13
Mar 20
Mar 27
Apr 3
Apr 10
communication between slaves and master
communication with android tablet
android app UI
Designing of the PCB
Purchasing of PCB
Testing


pr 17
Apr 24
W T F S S M T W T F S
ntrol
ludes temp probing)
sending) features
Dev
Imp
track